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A REVISION OF THE OSMERID FISHES OF THE
NORTH PACIFIC.
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The family of Osmeridae, or true smelts, is confined to Arctic and North Temperate waters. Like many other families of the Holarctic Realm, it is represented by more genera and species in the North Pacific than in the North Atlantic. The genus *Osmerus* alone is better developed in the latter region, where otherwise only one species, *Mallotus villosus*, occurs. A species of *Osmerus*, as well as *Mallotus villosus*, also occurs, however, along the Arctic coasts and also in the North Pacific. In addition, *Allosmerus attenuatus*, *Thaleichthys pacificus*, three species of *Spirinchus* and four species of *Hypomesus* characterize the North Pacific fauna. They are all compared in the following key.

In the preparation of this paper, nearly all the material preserved in American museums has been examined. We wish to thank the authorities of the National Museum, in particular, for the privilege of examining the specimens deposited in that institution.

KEY TO THE GENERA AND SPECIES OF OSMERIDAE.¹

- a¹. Scales of moderate size (fewer than 80 in the lateral line); scales on sides not forming villous bands in the breeding male.
- b¹. Teeth on the vomer canine-like, few in number, and not covering the whole head of the bone.
- c¹. Vomerine teeth confined to lateral tips of U-shaped vomer, fang-like, one to three in number on each side; teeth

¹With the exclusion of the Atlantic species of *Osmerus* and of *Therobromus callorhini* Lucas, known only from bones taken from the stomachs of fur seals, and perhaps not an Osmerid.

very strong, not deciduous at spawning. Pelvic fins inserted distinctly behind origin of dorsal.

(Genus *Osmerus*.)

- d¹. Gill-rakers in moderate number, 8 to 10 + 19 to 23 on first arch. Scales 66 to 69 in lateral line. Anal fin low, its height contained 2.6 to 3.3 times in head. Upper jaw about reaching vertical from posterior margin of eye. Spawning in streams.

Osmerus dentex.

- c². Vomerine canine moderate, inserted at front of vomerine arch (often flanked on one side by a smaller tooth); other teeth of moderate strength. Pelvic fins inserted distinctly in advance of origin of dorsal fin.

- e¹. Teeth larger and stronger; never deciduous. Head sharply pointed as seen from above. Opercles weakly striate. Gill-rakers longer, 10 or 11 + 22 to 26 in number on the first arch. Anal fin of moderate length, with 15 to 17 rays. Probably spawning in the ocean.

Allosmerus attenuatus.

- e². Teeth smaller and weaker; deciduous at spawning, the breeding fish being almost completely edentulous. Head bluntly rounded anteriorly, as seen from above. Opercles strongly striate concentrically. Gill-rakers much reduced in size and number, only 4 to 6 + 13 to 16 on first arch. Anal fin elongate, with 20 to 22 rays. Spawning in streams.

Thaleichthys pacificus.

- b². Teeth on the vomer not canine-like, rather numerous and forming a convex series along the entire head of the bone; teeth not deciduous, all small, or scarcely canine-like.

- f¹. Mouth large (as in all preceding genera and species). Teeth larger, always evenly uniserial on vomer and palatine bones.

(Genus *Spirinchus*.)

- g¹. Fins less elongate, the pectoral not longer than the head, and not reaching pelvic insertion.

- h¹. Pectoral fin, 1.25 to 1.4 in head; upper jaw, 1.8 to 1.9; eye, 3.6 to 4.4; head in length to caudal, 4.0 to 4.2. Spawning in the surf.....*Spirinchus starksii*.

- h². Pectoral fin longer, 1.1 to 1.25 in head; upper jaw, 2.0 to 2.15; eye, 4.4 to 4.8; head in standard length, 4.35 to 4.6.

Spirinchus lanceolatus.

g². Fins much enlarged, the pectoral longer than the head, and extending beyond pelvic insertion. Spawning in fresh water..... *Spirinchus thaleichthys*.

f². Mouth much smaller. Teeth minute; in biserial arrangement, or nearly so, on vomer and palatine bones.

(Genus *Hypomesus*.)

i¹. Scales larger than in *H. pretiosus*,

54 to 62 along lateral line. Pelvic fins usually inserted a little before origin of dorsal; fins all larger than in *pretiosus*, the pectoral reaching more than half-way to pelvic insertion. Color darker. Breeding at a small size in fresh water..... *Hypomesus olidus*.

i². Like *olidus*, but scales about 63 to 65 in number, and pelvic fins inserted distinctly behind origin of dorsal. (Breeding habits unknown.)

Hypomesus verecundus.

i³. Like *pretiosus*, but scales averaging larger, 63 to 68 in number along lateral line. (Breeding habits unknown.)

Hypomesus japonicus.

i⁴. Scales smaller, in 66 to 76 series along lateral line. Pelvic fins usually inserted behind origin of dorsal; fins all shorter than in *olidus*, the pectoral not reaching half-way to pelvic insertion. Color more silvery. Breeding at a larger size in the surf.

Hypomesus pretiosus.

a². Scales of small size (about 150 in the lateral line; scales on sides forming two villous bands in the breeding male. Mouth large. Teeth small..... *Mallotus villosus*.

Genus 1. OSMERUS Linnaeus.

1. *Osmerus dentex* Steindachner.

If all the Atlantic smelt be referred to a single species, as Smitt has proposed¹, then the Pacific form can not be satisfactorily distinguished.

¹History of Scandinavian Fishes, Pt. 2, 1895, p. 868.

According to this author, *dentex* differs constantly from *eperlanus* only in having fewer gill-rakers and a lower anal fin. That these distinctions fail to separate *dentex* from the Atlantic smelt as a whole is quite evident from our counts and measurements.

	<i>Osmerus dentex.</i>	Atlantic smelt.
Gill-rakers	8 to 10+19 to 23	7 to 11+15 to 24
Height of anal fin (in head)	2.6 to 3.3	2.3 to 3.4

The point of the matter is, that the Atlantic smelt may be divided into several local species (or subspecies). Excluding certain land-locked types from New England (*O. spectrum* Cope, *O. abbotti* Cope, and perhaps others), which are now being critically studied by W. C. Kendall, at least two forms may be recognized on each side of the Atlantic.

The smelt of the Eastern Atlantic, so far as observed by Smitt and ourselves, have higher anal fins than *dentex*. The Scandinavian form (which may be construed as typical *eperlanus*), however, has more gill-rakers than shown by English and French specimens examined; those on the lower limb of the outer arch number 22 to 26 instead of only 17 to 22; the total number is 32 to 37, rather than 25 to 32. It is not certain what name should be accredited to the form with the reduced number of gill-rakers.

The common smelt of the New England and Canadian coasts, probably Mitchell's *mordax* and certainly Le Sueur's *viridescens*, agrees with *dentex* in the low anal fin and low number of gill-rakers. South of New York it is (or was) represented by a smaller form with the anal distinctly higher and the gill-rakers still fewer. This southern species (possibly race) may be known as *Osmerus sargentii* Norris¹. The two forms may be characterized as follows:

	<i>O. mordax</i>	<i>O. sargentii</i>
Gill-rakers (first arch)	10 or 11+19 to 24	9 or 10+15 to 18
Height of anal in head	2.6 to 3.4	2.4 to 2.6

Of these five or more Atlantic forms, *Osmerus mordax* is most like the Pacific form. In fact the only reliable difference we can discover is in the backward extension of the upper jaw, and even this difference is not wholly constant. In the adult of *dentex* the end of the maxillary lies about on the vertical from the posterior margin of the orbit, while it falls more or less short of this vertical in all specimens of *mordax* examined. *Osmerus dentex* is apparently close also to the species of the Arctic Coast of Eurasia (called *dvinensis* or *spirinchus* by Smitt), but according to him that form has as many gill-rakers as the Scandinavian *eperlanus*. Smitt's claim that the Arctic species occurs in Alaska is not confirmed by our studies, for we have found only *dentex* from the northern coast of Alaska to Japan.

The record of *Osmerus dentex* from Matsushima Bay, Japan, by Smith and Pope² was based on a fish of a distinct family, namely *Plecoglossus altivelis*.

¹ Proc. Acad. Nat. Sci. Phila., 1868, p. 95. Types, and series from the Raritan River, New Jersey, examined.

² Proc. U. S. Nat. Mus., 31, 1906, p. 463.

Genus 2. *Allosmerus* Hubbs (new genus).

Type, *Osmerus attenuatus* Lockington.

This genus is intermediate in most respects between *Osmerus* and *Thaleichthys*. Its characters are given in the preceding key.

2. *Allosmerus attenuatus* Lockington.

Allosmerus attenuatus is common in and about San Francisco Bay, and ranges northward at least as far as Central Oregon ($44^{\circ} 56' N.$ $124^{\circ} 12' 30'' E.$). It probably spawns in the ocean. The development is much more protracted than that in *Spirinchus thaleichthys*, the young remaining in the translucent postlarval condition until a length of about three inches has been attained. It is a small species, a mature female only 104 mm. long to caudal having been examined.

Genus 3. *THALEICHTHYS* Girard.3. *Thaleichthys pacificus* Richardson.

This species ranges from the Klamath River in northern California to Bering Sea. During most of its life it is probably pelagic, but it ascends streams to spawn.

In the pelagic stage, named *Osmerus albatrossis* by Jordan and Gilbert (1898), the teeth are well developed. The breeding specimens, especially the males, are largely or entirely edentulous, but occasionally a few to many of the teeth may be retained. We have been able to trace a complete transition between "*Eperlanio*"¹ *albatrossis* and *Thaleichthys pacificus*.

Genus 4. *SPIRINCHUS* Jordan and Evermann.

This group of three very closely related species should certainly be recognized as generically distinct from *Osmerus*. The vomerine dentition, as outlined in the key, is particularly distinctive.

4. *Spirinchus starksii* Fisk.

Osmerus starksii Fisk, Proc. U. S. Nat. Mus. 46, 1913, p. 293, fig.

Re-examination of material shows that the records of *Osmerus thaleichthys* from Monterey, California, made by Jordan and Gilbert (1881) and by Fowler (1912) were based on specimens of this species. A good series of specimens, almost in the breeding condition, was obtained at Eureka, Humboldt County, northern California, where the species is known as the "night surf smelt" to distinguish it from *Hypomesus pretiosus*, which is known as the "day surf smelt." These specimens were seined on the beach near the mouth of Mad River.

5. *Spirinchus lanceolatus* Hikida.

Osmerus dentex Franz, Abh. bayer. Akad. Wiss., Suppl. 4, vol. 1, 1910, p. 6, pl. 3, fig. 5 (young, from Misaki).

¹*Eperlanio* Jordan, Proc. Acad. Nat. Sci. Phila., 1918 (1919), p. 341. Type *Osmerus albatrossis* Jordan and Gilbert.

"*Osmerus lanceolatus* Hikida, Zool. Mag., 25, 1913, p. 127, pl."

We have not seen Hikida's description (which we quote from the Zoological Record), but we have seen a specimen so named by Japanese ichthyologists. It is a tuberculate male, collected in Iburi, Hokkaido, and presented to Dr. Jordan by Dr. Kawamura. We have examined series from Kushiro and from Tomakomai in Japan, in both cases taken with *Osmerus denter*. A redescription of this species is being published by Jordan and Hubbs in the Memoirs of the Carnegie Museum.

S. lanceolatus is extremely like the Californian species *S. starksii*, but differs in details of proportions as indicated in the key.

6. *Spirinchus thaleichthys* Ayres.

This species has been rather extensively confused with other forms. As already observed, Monterey records were based on *S. starksii*. We find no basis for Jordan and Gilbert's (1881) records of San Luis Obispo and Puget Sound. The records of *thaleichthys* from Nushagak River, Alaska, which have several times appeared in the literature¹ refer to *Hypomesus olidus*, as Gilbert's brief description and a reexamination of the material both show.

This species is very abundant in San Francisco Bay, from which it ascends the Sacramento River to spawn (as Mr. N. B. Scofield has determined). From this locality it ranges northward to near Cape Flattery, Washington.

Genus 5. HYPOMESUS Gill.

The generic name *Hypomesus* Gill under the present rules should be adopted in preference to *Mesopus* Gill, given to the same group on the preceding page, but left as a typographical error (failure to correct proof carefully).

7. *Hypomesus olidus* Pallas.

It is not clear that *Salmo inghaghitsch* Walbaum can be identified with this species, for which Pallas' name *olidus* should apparently be retained. *Osmerus oligodon* Kner is a synonym of this species, not of *japonicus*, as currently claimed.²

Hypomesus olidus has very generally been confused with *H. pretiosus*, *H. japonicus* and even with *Spirinchus thaleichthys* (which see). It differs sharply from *pretiosus* in the larger size of the scales, there being 54 to 62 rather than 66 to 76 in the course of the lateral line; usually in the more anterior position of the pelvic fins in reference to the dorsal, the pelvic insertion being in most cases in advance of, instead of a little behind, the vertical from the dorsal origin; in the much larger size of all the fins, the pectoral reaching more, instead of less, than half-way to the pelvic insertion; in the darker color; in the smaller size attained, and in the habit of spawning in fresh-water rather than in the surf of ocean beaches. It

¹Gilbert, Rept. U. S. Fish Comm., 1893 (1895), p. 400; Jordan and Evermann, Bull. U. S. Nat. Mus., 47, pt. 1, 1896, p. 522; Jordan and Gilbert, Rept. Fur Seal Invest., 3, 1898, p. 440; Evermann and Goldsborough, Bull. U. S. Bur. Fish., 26, 1906 (1907), p. 40 (not figure).

²Denksch. Akad. Wiss. Wien. 24, 1865, p. 9, pl. 4, fig. 1.

differs from *japonicus* in the same respects, with the exception that the latter has an intermediate number of scales (63 to 68), and the breeding habits unrecorded. We have examined more and larger series of these species than have been available to other workers, yet find no good evidence to support the claim, several times asserted, that these forms intergrade, or that they are identical in characters.

Hypomesus olidus ranges from the mountain lakes of central Japan and the shores and coastwise fresh-waters of northern Japan, northward through Kamchatka to the Arctic shores of North America; thence southward along the east side of the North Pacific as far as the upper or brackish portions of San Francisco Bay.

8. *Hypomesus verecundus* Jordan and Metz.

Spirinchus verecundus Jordan and Metz. Mem. Carn. Mus., 6, 1913, p. 11, pl. 1, fig. 2.

We have re-examined the three types of this Korean species (these being the only specimens recorded) and have found that the species is in every respect typical of *Hypomesus*. It is intermediate in its characters between *olidus* and *japonicus*, as indicated in our key.

9. *Hypomesus japonicus* Brevoort.

Osmerus oligodon Kner has been quoted as a synonym of this species, but it was based on a specimen of *olidus*.

Hypomesus japonicus seems to be most closely related to the Korean *vereценus* and the Eastern Pacific *pretiosus*. It represents those species in northern Japan and Kamchatka. Material from the latter region (collected at Petropavlovsk) was erroneously identified by Jordan and Gilbert¹ as *Mesopodus olidus*.

10. *Hypomesus pretiosus* Girard.

This species occurs along ocean beaches from southern Alaska to central California. It has been rather extensively confused in the literature with *H. olidus*.

Genus 6. *MALLOTUS* Cuvier.

11. *Mallotus villosus* Müller.

We have examined specimens of capelin from many localities extending from northern Japan eastward to Sweden, but have not critically studied the material. Such an investigation might yield results of considerable interest.

¹Rept. Fur Seal Inv., 3, 1898, p. 440.

